DESCRIPTION

DATA PROCESSOR

TECHNICAL FIELD

[0001] The present invention relates to a technique of receiving a data stream such as a digital broadcast and recording the stream on a storage medium that has been inserted into a data processor loadable with a number of different types of storage media.

BACKGROUND ART

[0002] Since digital broadcasting launched, people have more and more opportunities to watch and listen to video and audio of higher quality than the video and audio of conventional analog broadcasting. For example, the video of a conventional analog broadcast is presented by interlaced scanning using 525 scan lines, and is called "standard resolution video" or "standard definition (SD) video". Meanwhile, the video of a digital broadcast is presented by either a similar interlaced scanning technique that uses

1,125 scan lines or a progressive scanning technique that uses 525 scan lines, and its quality is higher than that of the SD video. That is why the video of a digital broadcast is called "high resolution video", "high quality video" or "high definition (HD) video". In this description, the video to be presented either by using the greater number of scan lines than the SD video or by the progressive scanning technique will be referred to herein as "HD video".

[0003] Recently, HD video recorders have become increasingly popular among consumers. To record HD video without lowering its quality, a storage medium that can store the HD video as digital data while maintaining a required data transfer rate for reading and writing the HD video is needed. Patent Document No. 1 discloses a recorder/player for recording and playing HD video by using a hard disk as such a storage medium. This recorder/player also has the function of writing data on a normal optical disk, on which only SD video data can be stored, and can dub the video on the hard disk onto such an optical disk.

Patent Document No. 1: Japanese Patent Application Laid-

Open Publication No. 2002-330401

DISCLOSURE OF INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004] This recorder/player writes HD video data by the data transfer rate and storage capacity of its unremovable hard disk and is not supposed to adopt a processing mode not using the hard disk when receiving the HD video data. If the user wants to store the contents of the HD video on a normal optical disk, then he or she must record the HD video on the hard disk once, get it converted into SD video, and then have the SD video dubbed onto the normal optical disk, which forces him or her to wait a long time. This recorder/player is far from coming in handy since the user needs to instruct the dubbing operation after the recording operation is finished.

[0005] Thus, an object of the present invention is to have a drive, loadable with a number of different types of storage media, directly record a data stream on a given storage medium at a write rate and in a recording format associated with that storage medium.

MEANS FOR SOLVING THE PROBLEMS

[0006] A data processor according to the present invention is loadable with a first type of storage medium and a second type of storage medium and records a data stream on a storage medium loaded. A data stream representing video of standard resolution is recordable in a first format on the first type of storage medium, while a data stream representing video of either the standard resolution or a resolution higher than the standard resolution is recordable in a second format on the second type of storage medium. The data processor includes: a drive, which is loaded with a storage medium, for recognizing the type of the storage medium loaded; a processing section for receiving a data stream in the second format, for extracting a video data stream from the data stream, and for detecting a resolution of the video; a switch for sending a data stream, resulting from the data stream in the second format, along a first path if the first type of storage medium is loaded and if the video is of the higher resolution, and for sending the data stream in the second

format along a second path if the second type of storage medium is loaded and if the video is of the standard resolution; a converting section for converting the resolution of the video of the data stream, received by way of the first path, into the standard resolution; and an encoder for generating a data stream in the first format from the data stream of which the resolution has been converted into the standard resolution. The drive writes the data stream supplied from the encoder and the data stream received by way of the second path on the storage medium loaded.

[0007] The data processor may further include an analog signal processing section for receiving an analog signal representing video and for generating a data stream representing video of the standard resolution. The encoder may generate a data stream in the first format from the data stream that has been generated by the analog signal processing section.

[0008] The data processor may further include a control section for receiving in advance, and managing, time information about recording start and end times. The control

section may instruct the processing section to start and stop receiving the data stream in the second format in accordance with the time information.

[0009] The converting section may add resolution information about original resolution before the conversion to the data stream that has been converted into the video of the standard resolution. The encoder may generate the data stream in the first format including the resolution information.

[0010] If the second type of storage medium is loaded and if the video has the higher resolution, the switch may send the data stream in the second format along the second path.

[0011] If the second type of storage medium is loaded and if the video has the higher resolution, the switch may send a data stream, resulting from the data stream in the second format, along the first path. The encoder may generate the data stream in the second format from the data stream, of which the resolution has been converted into the standard resolution by the converting section.

EFFECTS OF THE INVENTION

[0012] When loaded with a storage medium on which a data stream representing standard resolution video is recordable and when receiving a data stream representing high resolution video, the data processor of the present invention converts the high resolution video into the standard resolution video and then record it on the storage medium. In this case, since the format of the data stream received is different from that of the data stream recordable on the storage medium, a data stream in a format compatible with the storage medium is generated. On the other hand, when loaded with a storage medium on which a data stream representing high resolution video is recordable, the data processor record the data stream on the storage medium as it is without converting its resolution or format. No matter whether the data stream received represents high resolution video or standard resolution video, the data processor can record the data stream directly on such a storage medium. Accordingly, compared to the situation where data is temporarily stored somewhere, subjected to a predetermined conversion, and then written elsewhere finally, not only the temporary storage

space but also the time and trouble of reconversion and rerecording can be saved. As a result, the hardware resources can be used more efficiently and the convenience and handiness can be improved for the users.

[0013] Optionally, the data may be temporarily stored and then the reconversion and rerecording processes may be performed such that the recording operation preset by the user is carried out just as he or she wishes even if he or she failed to insert a storage medium.

BRIEF DESCRIPTION OF DRAWINGS

[0014]

FIG. **1** shows the data structure of an MPEG-2 transport stream **10**.

FIG. **2(a)** shows the data structure of a video TS packet **30**, and FIG. **2(b)** shows the data structure of an audio TS packet **31**.

Portions **(a)** to **(d)** of FIG. **3** show a correlation between video TS packets and video pictures.

FIG. **4** shows an arrangement of functional blocks in a

recorder **100**.

FIGS. **5(a)** and **5(b)** show the configuration of, and the processing done by, the resolution converting section **130**.

FIG. **6** shows correspondence between pixels of HD video and those of SD video being generated by arbitrarily adjusting the resolution of the HD video.

FIG. **7** shows the arrangement of functional blocks in an MPEG2-PS/TS encoder **138**.

Portions **(a)** through **(c)** of FIG. **8** show the data structure of a PS.

FIG. **9** is a flowchart showing the procedure of processing done by the recorder **100** that is receiving a digital signal.

FIG. **10** is a flowchart showing the procedure of PS generating processing done by the recorder **100**.

FIG. **11** is a flowchart showing the procedure of recording processing done by the recorder **100**.

FIG. **12** is a flowchart showing the procedure of dubbing processing done by the recorder **100**.

DESCRIPTION OF REFERENCE NUMERALS

[0015]

100 optical disk recorder

102 DVD

104 BD

106 HDD

108a digital signal receiving section

108b IEEE 1394 interface

110 digital signal processing section

112 stream extracting section

114, 132, 134, 136 switch

116 decoder

120 analog signal processing section

130 resolution converting section

138 MPEG2-PS/TS encoder

140 system control section

142 video recording control section

144 drive control section

146 memory card control section

BEST MODE FOR CARRYING OUT THE INVENTION

[0016] Hereinafter, an optical disk recorder with a hard disk drive will be described as a preferred embodiment of a data processor according to the present invention. The optical disk recorder can receive a data stream representing HD video and/or SD video as digital broadcast and record the data stream on either a removable storage medium inserted or its unremovable storage medium. The storage medium may be a Blu-ray disc (BD), a DVD-R, a DVD-RAM, a hard disk or an SD memory card. This optical disk recorder changes the formats and video resolutions of a data stream to write according to the type of the storage medium on which the data stream is going to be written.

[0017] A BD is an optical disk from/on which data is read or written using a violet laser beam with a wavelength of 405 nm. The BD has a storage capacity of about 25 GB per data storage layer and requires a data transfer rate of about 36 megabits per second. On the other hand, a DVD-R and a DVD-RAM are optical disks from/on which data is read or written using a red laser beam with a wavelength of 650 nm. The DVDs have a

storage capacity of about 4.7 GB per data storage layer. A DVD-RAM version 2.0 requires a data transfer rate of about 22 megabits per second.

[0018] Hereinafter, the data structure of a data stream of a digital broadcast will be described with reference to FIGS. **1** through **3**. After that, the configuration and operation of an optical disk recorder that receives the data stream will be described with reference to FIGS. **4** through **9**.

[0019] FIG. **1** shows the data structure of an MPEG-2 transport stream **10**. The MPEG-2 transport stream **10** (which will be referred to herein as "TS **10**") includes a plurality of TS object units (TOBUs) **21**, each of which includes at least one transport packet (TS packet). Examples of those TS packets include a video TS packet (V_TSP) **30** in which compressed video data is stored, an audio TS packet (A_TSP) **31** in which compressed audio data is stored, a packet (PAT_TSP) in which a program association table (PAT) is stored, a packet (PMT_TSP) in which a program map table (PMT) is stored, and a packet (PCR_TSP) in which a program clock reference (PCR) is stored. Each of these packets has a data size of 188 bytes.

[0020] Hereinafter, the video TS packets and audio TS packets will be described. FIG. **2(a)** shows the data structure of a video TS packet **30**. The video TS packet **30** includes a transport packet header **30a** of 4 bytes and video data **30b** of 184 bytes. On the other hand, FIG. **2(b)** shows the data structure of an audio TS packet **31**. The audio TS packet **31** also includes a transport packet header **31a** of 4 bytes and audio data **31b** of 184 bytes.

[0021] As can be seen from this example, a TS packet usually consists of a transport packet header of 4 bytes and elementary data of 184 bytes. In the packet header, a packet ID (PID) showing the type of that packet is described. For example, the PID of a video TS packet is 0x0020, while that of an audio TS packet is 0x0021. The elementary data may be content data such as video data or audio data or control data for controlling the playback. The type of the data stored there changes according to the type of the packet. It should be noted that the data storage area of a TS packet, following the TS packet header, is called a "payload" when content data such as video data or audio data is stored there and an

"adaptation field" when control data is stored there, respectively.

[0022] Portions **(a)** to **(d)** of FIG. **3** show a correlation between video TS packets and video picture data. As shown in portion **(a)** of FIG. **3**, this TS **10** includes video TS packets **40a** through **40d.** Although the TS **10** may include other packets, only those video TS packets are shown here. A video TS packet can be easily identifiable by the PID stored in its header **40a-1**.

[0023] A packetized elementary stream is made up of the video data of respective video TS packets such as the video data **40a-2**. Portion **(b)** of FIG. **3** shows the data structure of a packetized elementary stream (PES) **41.** The PES **41** includes a plurality of PES packets **41a, 41b,** etc. The PES packet **41a** is made up of a PES header **41a-1** and picture data **41a-2**. These data are stored as the video data of the video TS packets.

[0024] The picture data **41a-2** includes the data of respective pictures. An elementary stream is made up of those picture data **41a-2**. Portion **(c)** of FIG. **3** shows the data

structure of an elementary stream (ES) **42**. The ES **42** includes multiple pairs of picture headers and frame or field data. It should be noted that although the "picture" is generally used as a term that may refer to either a frame or a field, the "picture" is supposed herein to be a frame.

[0025] In the picture header **42a** shown in portion **(c)** of FIG. **3**, a picture header code, showing the picture type of the following frame data **42b**, is described. In the same way, a picture header code, showing the picture type of the following frame data **42d**, is described in the picture header **42c**. The "type" is one of an I-picture (I-frame), a P-picture (P-frame) and a B-picture (B-frame). If the type shows this is an I-frame, its picture header code may be "00_00_01_00_20_08", for example.

[0026] The frame data **42b**, **42d**, etc. is data corresponding to a single frame, which may consist of either that data only or that data and preceding/succeeding data to be decoded before and/or after the former data. For example, portion **(d)** of FIG. **3** shows a picture **43a** consisting of the frame data **42b** and a picture **43b** consisting of the frame data **42d**. Each

picture is a collection of pixels **44** and the vertical and the numbers of horizontal and vertical pixels are defined according to the resolution.

[0027] The TS **10** is recorded on a BD and a hard disk while maintaining the data structure shown in FIG. **1**. The data write rate required by the BD and hard disk is higher than the data transfer rate of a data stream representing HD video. Thus, the HD video can be recorded thereon without debasing its quality. SD video may also be recorded on a BD and a hard disk, too.

[0028] Meanwhile, the TS **10** cannot be recorded on a DVD. This is because a data stream that can be recorded on a DVD should be formatted as an MPEG2-PS program stream (to be described later) according to the standards. Also, since the data write rate required by the DVD is lower than the data transfer rate of a data stream representing HD video, the HD video cannot be recorded on a DVD without sacrificing its quality.

[0029] Hereinafter, the configuration and functions of the optical disk recorder **100** with a hard disk will be described

with reference to FIG. **4**.

[0030] FIG. **4** shows an arrangement of functional blocks in the optical disk recorder **100** with a hard disk (which will be simply referred to herein as the "recorder **100**"). The recorder **100** includes a hard disk drive (HDD) **106**, a digital signal receiving section **108a**, an IEEE 1394 interface **108b**, a digital signal processing section **110**, an analog signal processing section **120**, a resolution converting section **130**, switches **132**, **134** and **136**, an MPEG2-PS/TS encoder **138**, a system control section **140**, a video recording control section **142**, a drive control section **144**, and a memory card control section **146**. The recorder **100** is loaded with a recordable DVD **102** or a BD **104**. The DVD **102** may be a DVD-RAM or a DVD-R, for example. In this preferred embodiment, the same slot is used for inserting the DVD **102** and BD **104**. That is to say, the recorder **100** is supposed to be loaded with one of these two types of disks, not both, at a time. The recorder **100** can write data on either the DVD **102** or the BD **104** independently of the HDD **106**.

[0031] Hereinafter, the functions of the recorder **100** will

be outlined. Before recording a digital broadcast received, the recorder **100** recognizes the type of the given optical disk as a DVD **102** or a BD **104**. When loaded with the BD **104**, the recorder **100** records the TS **10** as it is on the BD **104** no matter whether the video represented by the TS **10** received is HD video or SD video. On the other hand, when loaded with the DVD **102**, the recorder **100** needs to convert the TS **10** into a program stream (which will be abbreviated herein as a "PS"). In that case, the recorder **100** determines whether the video represented by the TS **10** being received is HD video or SD video. If the video received is SD video, then the recorder **100** generates a PS without debasing its quality and records the PS on the DVD **102**. Meanwhile, if the video received is HD video, then the recorder **100** converts the HD video into SD video and then generates a PS and records it on the DVD **102**. By performing these processing steps, the recorder **100** directly records the data stream on the given optical disk at a write rate and in a data format associated with that optical disk. Thus, there is no need to temporarily store the data stream and a broadcast received can finish being recorded on

the optical disk the instant the broadcast ends.

[0032] It should be noted that the recorder **100** includes the HDD **106** and can store the TS **10** in the HDD **100** instead of the BD **104.** In this preferred embodiment, if the recorder **100** is loaded with neither the DVD **102** nor the BD **104,** then the TS **10** is stored on the HDD **106** to avoid failing to record a designated program.

[0033] Hereinafter, the respective components of the recorder **100** will be described one by one. The TS processing system will be described first, and then the analog signal processing system will be described.

[0034] The digital signal receiving section **108a** receives a broadcast wave, digitizes its signal waveform, and then outputs the digital signal as a TS **10.** The IEEE 1394 interface (I/F) **108b** controls the exchange of data between an external connected device (not shown) and the recorder **100** and can acquire the TS **10** from that device, too.

[0035] The digital signal processing section **110** receives the TS **10** from the digital signal receiving section **108a,** IEEE 1394 I/F **108b** and drive control section **144.** Also, the

digital signal processing section **110** either outputs the TS **10** as it is or decodes the TS **10** and outputs non-compressed digital video signal and digital audio signal according to predetermined conditions.

[0036] The digital signal processing section **110** includes a stream extracting section **112**, a switch **114** and a decoder **116.** The TS **10** may include data streams representing a plurality of programs. In that case, the stream extracting section **112** extracts a data stream representing a particular program in accordance with the instruction of the system control section **140** on the channel selection. More specifically, the stream extracting section **112** extracts the program association table packet (PAT_TSP) and program map table packet (PMT_TSP) shown in FIG. **1**, thereby extracting a data stream concerning a content that represents a designated program. Suppose the channel number of the designated program is X. In that case, first, the TS packets are searched for the program association table packet. The packet ID (PID) of the program association table packet may be zero, for example. Thus, a packet having that value may be searched for. In the

program association table in the program association table packet, respective channel numbers and the program map table PIDs of respective programs associated with those channel numbers are stored. Thus, the packet ID (PID) of the program map table (PMT) associated with the channel number X can be detected. The PID of the program map table PMT is supposed to be XX.

[0037] Next, when the program map table packet with PID=XX is extracted, a program map table associated with the channel number X can be obtained. The program map table PMT includes the PIDs of TS packets, in which the video and audio information of each program to watch and listen to is stored. For example, the PID of the video information associated with the channel number X may be XV and the PID of the audio information thereof may be XA. By using the PID (=XV) of the packet storing the video information and the PID (=XA) of the packet storing the audio information, the video and audio packets about a particular program content can be extracted from a single TS. A data stream made up of those extracted packets is also a TS. Strictly speaking, the TS received is

different from the TS consisting of the extracted packets. However, these TS are supposed herein to be identical with each other for convenience sake.

[0038] Also, the stream extracting section **112** determines, by the descriptor in the header of the stream, for example, whether the video extracted from the TS is SD video or HD video. The descriptor indicates whether the quality of video is SD or HD. The stream extracting section **112** also outputs resolution information showing the resolution.

[0039] The switch **114** switches the transmission paths of the TS in accordance with the disk type information provided by the system control section **140** and the resolution information provided by the stream extracting section **112** as will be described later. More specifically, if the recorder **100** is loaded with the DVD **102** and if the video of the TS is HD video, then the switch **114** outputs the TS to the path to which the decoder **116** is connected. On the other hand, if the recorder **100** is loaded with the BD **104**, if the HDD **106** has been selected as the storage of the TS, or if the recorder **100** is loaded with neither the DVD **102** nor the BD **104**, then the

switch **114** outputs the TS to the path to which a switch **132** is connected. The situation where the recorder **100** is loaded with neither the DVD **102** nor the BD **104** is taken into account in order to make the recorder **100** record the TS on the HDD **106** and thereby avoid missing the program selected due to the failure to insert any disk. For the same reasons, even if the recorder **100** is loaded with the DVD **102** or the BD **104** but if its remaining storage capacity is equal to or less than a predetermined value, then the switch **114** may change the paths so as to output the TS to the path to which the switch **132** is connected.

[0040] The decoder **116** receives the TS from either the switch **114** or the drive control section **144** and splits the TS into video and audio packets, thereby acquiring video data and audio data. Then, the decoder **116** decompresses the compressed and encoded video data to generate and output a non-compressed digital video signal (compliant with the REC 656 or 601 standard, for example). At this point in time, the quality of the HD video or SD video does not change. This digital video signal contains digital data on a video frame basis. The

decoder **116** also decodes the compressed and encoded audio data, thereby outputting a non-compressed digital audio signal. This digital audio signal contains digital data on an audio frame basis.

[0041] The resolution converting section **130** receives the non-compressed digital video signal. If the signal represents HD video, then the resolution converting section **130** converts the HD video into SD video. On the other hand, if the signal represents SD video, then the resolution converting section **130** outputs the SD video as it is. Hereinafter, the process of converting the HD video into the SD video will be described with reference to FIGS. **5(a)** and **5(b)**, which illustrate the configuration of, and the processing done by, the resolution converting section **130**. The resolution converting section **130** sequentially receives pixel data, representing the pixel **44** (see FIG. **3(d)**) and other pixels, performs predetermined calculations on those pixel data received, and outputs a single pixel data. That is to say, the resolution converting section **130** changes multiple pixels of the HD video into a single pixel of the SD video.

[0042] To produce SD video by halving the vertical and horizontal resolutions of the HD video, for example, the calculation may be done in the following manner. Specifically, in that case, the resolution converting section **130** receives the pixel data of respective pixels P (i, j-2), P (i-1, j-1), P (i, j-1), P (i+1, j-1) and P (i, j) of the HD video shown in FIG. **5(b)** and gets their transfer delayed by the delay circuits **130a** through **130e** for a predetermined amount of time. And these pixel data are multiplied by a predetermined filter coefficient when obtained at the same time, and then the products are input to a computation unit **131**. In response, the computation unit **131** calculates the weighted average of those products, thereby outputting the pixel data of a pixel Q (i, j-1). In this manner, the HD video can be converted into the SD video. In the example illustrated in FIGS. **5(a)** and **5(b)**, one pixel of the SD video to be output consists of five adjacent pixels. However, the SD video may also be generated from multiple discrete pixels, too. Alternatively, SD video, of which the vertical and horizontal resolutions have been halved from those of the HD

video, may also be produced just by adopting every other pixel data of the HD video. In either case, by setting the filter coefficient so as to produce no reflected distortion by a known technique, the resolution can be converted from a certain number of pixels into any desired number of pixels.

[0043] FIG. **6** shows correspondence between pixels of HD video and those of SD video being generated by arbitrarily adjusting the resolution of the HD video. By appropriately changing the filter coefficients, the resolution converting section **130** can generate the solid-circle pixels from the pixels of the HD video, indicated by the open circles, and can produce SD video consisting of the solid-circle pixels. The correlation between the filter coefficient value and the output data has been researched extensively. Thus, by consulting those researches, it can be determined easily what filter coefficient should be adopted to output desired data. That is why in this preferred embodiment, a specific method of deriving the filter coefficient will not be described in detail.

[0044] The switch **132** makes a signal path such that the TS

10 is transmitted from the digital signal processing section **110** to the drive control section **144.** Also, if a data stream (i.e., a TS or a PS) has been output from the MPEG2-PS/TS encoder **138** as will be described later, then the switch **132** forms a signal path such that the data stream will be transmitted to the drive control section **144.**

[0045] If the incoming signals are digital signals, the switches **134** and **136** switch signal paths such that the digital video signal representing the SD video and supplied from the resolution converting section **130** and the digital audio signal supplied from the digital signal processing section **110** are both transmitted to the encoder **138.** On the other hand, if the incoming signals are analog signals, the switches **134** and **136** switch signal paths such that the digital video and audio signals supplied from the analog signal processing section **120** are transmitted to the encoder **138.**

[0046] The MPEG2-PS/TS encoder **138** (which will be simply referred to herein as the "encoder **138**") receives the digital video and audio signals and generates a TS or a PS. FIG. **7** shows an arrangement of functional blocks for the MPEG2-PS/TS

encoder **138**. The encoder **138** generates a TS when receiving disk type information showing that the given disk is the BD **104** but generates a PS when receiving disk type information showing that the given disk is the DVD **102**.

[0047] The encoder **138** has two paths for processing the digital video signal and the digital audio signal, respectively. First, it will be described how the encoder **138** processes the TS. The TS generating process corresponds to the process of sequentially making up the ES **42** shown in portion **(c)** of FIG. **3**, the PES **41** shown in portion **(b)** of FIG. **3** and then the TS **10** of the respective frame data shown in portion **(d)** of FIG. **3**. This is why this process will be described using the reference numerals shown in FIG. **3** when needed.

[0048] First, the video encoder **70a** shown in FIG. **7** receives a non-compressed digital video signal, which contains data on a frame-by-frame basis. The video encoder **70a** subjects that data to a compression and encoding process compliant with the MPEG-2 standard, adds picture headers **42a** and **42c** thereto, and then outputs the ES **42**. A PES generating

section **71a** receives the ES **42** as picture data and adds PES headers **41a-1**, etc., thereby generating PES packets. The PES packets are output as PES **41** one after another. In accordance with the disk type information described above, a switch **72a** outputs the PES **41**, supplied from the PES generating section **71a**, to a video TS packet generating section **73a**, which divides the PES **41** and adds a TS packet header **40a-1**, etc., thereby generating a video TS packet (V_TSP) of 188 bytes (see FIG. **2(a)**) and outputting it to a multiplexing section **75**.

[0049] Meanwhile, the digital audio signal is also processed in a similar manner. Specifically, an audio encoder **70b** subjects data contained in the digital audio signal to a compression and encoding process compliant with a predetermined standard, and adds headers thereto, thereby generating an elementary stream. A PES generating section **71b** adds PES headers to the elementary stream, thereby generating PES packets on an audio frame basis. The PES packets are output as PES one after another. In accordance with the disk type information described above, a switch **72b** outputs the PES, supplied from the PES generating section **71b**, to an audio

TS packet generating section **73b**, which divides the audio PES and adds a TS packet header, thereby generating an audio TS packet (A_TSP) of 188 bytes (see FIG. **2(b)**) and outputting it to the multiplexing section **75**.

[0050] The multiplexing section **75** receives the video and audio TS packets and outputs a TS in which respective types of packets are arranged as shown in FIG. **1**.

[0051] Hereinafter, it will be described with reference to portions **(a)** through **(c)** of FIG. **8** (when necessary) how the encoder **138** generates a PS. Portions **(a)** through **(c)** of FIG. **8** show the data structure of the PS.

[0052] First, the video encoder **70a** shown in FIG. **7** receives a non-compressed digital video signal, which contains data on a frame-by-frame basis. The video encoder **70a** subjects that frame data to a compression and encoding process compliant with the MPEG-2 standard, thereby generating picture data. Then, the compressed and encoded picture data is sent to the PES generating section **71a**.

[0053] The PES generating section **71a** adds a PES header **81-1** to the picture data, thereby generating a PES packet.

Portion **(a)** of FIG. **8** shows the data structure of the PES packet **81**. In the PES packet **81**, the PES header **81-1** is followed by the compressed and encoded picture data **81-2**. A number of PES packets are sequentially output as PES.

[0054] Next, when the disk type information received indicates that the recorder is now loaded with the DVD **102**, the switch **72a** outputs the PES **81**, supplied from the PES generating section **71a**, to a video pack generating section **74a**, which adds a pack header and a PES header to the pack data that has been obtained by dividing the picture data **81-2**, thereby generating a video pack (V_PCK) of 2,048 bytes and outputting it to the multiplexing section **75**. Portion **(b)** of FIG. **8** shows the data structure of a pack sequence. Two packs are shown in portion **(b)** of FIG. **8**. Taking the first pack **82** as an example, the pack header **82-1**, PES header **82-2** and pack data **82-3** are arranged in this order in the pack **82**.

[0055] Meanwhile, the digital audio signal is also processed in a similar manner. Specifically, the audio encoder **70b** subjects data contained in the digital audio signal to a compression and encoding process compliant with a

predetermined standard, thereby generating audio data. Then, the audio data is sent to the PES generating section **71b**. The PES generating section **71b** adds a header to the audio data, thereby generating a PES packet. In accordance with the disk type information described above, the switch **72b** outputs the PES, supplied from the PES generating section **71b**, to an audio pack generating section **74b**, which divides the audio PES and adds a pack header and a PES header, thereby generating an audio pack (A_PCK) of 2,048 bytes and outputting it to the multiplexing section **75**.

[0056] The multiplexing section **75** receives the video packs and the audio packs, arranges them appropriately, and outputs a PS. Portion **(c)** of FIG. **8** shows the data structure of the PS **83** generated by the multiplexing section **75**. It can be seen that the video and audio packs **82** and **84** are arranged as a mixture in the PS **83**.

[0057] Referring back to FIG. **4**, the drive control section **144** controls exchange of data with the optical disk drive and the HDD **106**. The drive control section **144** may be a controller compliant with the ATA standard or the ATAPI

standard, for example. In the optical disk drive and HDD **106**, with which the drive control section **144** exchanges data, control circuits for controlling the respective drives are provided. Thus, the drive control section **144** actually exchanges data with those control circuits. It should be noted that the optical disk drive includes not only the control circuit but also a spindle motor for turning the DVD **102** or the BD **104** and an optical head (not shown) for radiating a semiconductor laser beam with an appropriate wavelength toward the DVD **102** or BD **104** to record a data stream thereon. The HDD **106** also includes a spindle motor for turning the hard disk and a magnetic head (none of which is shown).

[0058] The drive control section **144** gets information about the type of the optical disk inserted by the user from the DVD drive or the BD drive and conveys that information to the system control section **140**. As a result, it can be seen whether the optical disk inserted is the BD **104** or the DVD **102**. On top of that, if it is a DVD, then it can also be seen whether the DVD **102** inserted is a DVD-R or a DVD-RAM.

Then, the system control section **140** can see whether or not the incoming stream needs to be subjected to a resolution conversion or a format conversion.

[0059] The control circuit of the DVD or BD drive may recognize the type of the given optical disk by any of various techniques. For example, disk type information, showing the type of an optical disk, may be recorded on the innermost area of the optical disk during the manufacturing process thereof and the control circuit of the drive may read the disk type information optically using the optical head (not shown). Also, when a laser beam is radiated toward an optical disk, the intensity of the light reflected from the optical disk changes with the type of the optical disk given as a storage medium. That is why the type of the given optical disk may also be recognized by making the control circuit detect the intensity of that reflected light. Furthermore, if an optical disk stored in a cartridge is inserted, then the control circuit may recognize the type of the given optical disk by the shape of the cartridge that changes according to the type of the storage medium. In any case, the disk type may be

recognized by the optical or physical properties of the optical disk inserted.

[0060] The drive control section **144** receives the TS or PS and writes it on the built-in HDD **106** or the DVD **102** or BD **104** inserted. In this preferred embodiment, the drive control section **144** can write any of the TS and the PS on the HDD **106**, the TS on the BD **104**, and the PS on the DVD **102**, respectively. However, depending on the type of the DVD **102** (such as a DVD-R or a DVD-RAM), the type of the PS that can be written on the DVD changes. In this case, the "type of the PS" is supposed to be one of the DVD Video standard and the DVD Video Recording standard that were defined as two major standards for program streams.

[0061] The system control section **140** is a CPU that performs overall control on the operation of the recorder **100**. Specifically, the system control section **140** carries out its function by making the recorder **100** operate on the procedure to be described later with reference to FIGS. **9** through **12**. The control operation performed by the system control section **140** is defined by a program that is stored in

advance in a memory (not shown). The system control section **140** receives a user's command to record a program and outputs an instruction to select a channel on which the program in question will be broadcast. When carrying out a preset recording operation, the system control section **140** also outputs an instruction to select a channel on which the pre-selected program will be broadcast. Also, in fulfilling the request of preset recording, the system control section **140** receives a request to perform video recording and preset recording information from the video recording control section **142** (to be described below) and makes the digital signal processing section **110**, encoder **138**, drive control section **144** and so on carry out the video recording process in accordance with that request and preset recording information.

[0062] The video recording control section **142** is provided for the purpose of controlling the preset recording operation, and receives in advance the preset recording information about the details of the preset recording operation to carry out from the user and manages that information. Examples of the preset recording information

include time information about the recording start and end times and channel information about the number of channel to select. When it is the recording start time specified by the time information, the video recording control section **142** requests the system control section **140** to carry out the recording operation and transmits the preset recording information. In response to this request, the system control section **140** instructs the stream extracting section **112** to select the channel and start receiving a TS. Thereafter, the system control section **140** gets the TS received continuously until the recording end time, when the system control section **140** instructs the stream extracting section **112** to stop receiving the TS. It should be noted that the time information and channel information are input through a hardware button or a remote controller (not shown) of the recorder **100** and transmitted to the video recording control section **142**.

[0063] The memory card control section **146** controls exchange of data between a memory card that has been inserted into the recorder **100** and the recorder **100** itself. The memory

card is a semiconductor storage medium and may be an SD memory card or a memory stick, for example, according to the standards. The memory card inserted into the recorder **100** is supposed herein to be an SD memory card **148**.

[0064] In the preferred embodiment described above, the recorder **100** is supposed to include the digital signal receiving section **108a**. However, the digital signal receiving section **108a** may also be provided separately from the recorder **100** (e.g., within a settop box). In that case, the TS may be received by way of the IEEE 1394 I/F **108b**.

[0065] Next, the analog signal processing system will be described. The analog signal processing section **120** receives an analog video signal and an analog audio signal, converts them into digital signals, and outputs the digital signals. The analog video signal and the analog audio signal may be terrestrial TV signals or signals received from an external device such as a VCR. The video represented by the analog video signal is supposed to be SD video.

[0066] The analog signal processing section **120** includes an analog signal receiving section **122**, a video/audio

switching circuit **124,** a video A/D converter **126** and an audio A/D converter **128.** The analog signal receiving section **122** may be an analog tuner, for example, and selectively outputs an analog video/audio signal of the selected channel from the terrestrial TV signal that has been received through an antenna (not shown). Also, the analog signal receiving section **122** may be a line input terminal, which receives an analog video/audio signal from an external device and outputs it. The analog video/audio signal includes a video signal in an analog format and an audio signal in an analog format. The video/audio switching circuit **124** splits the analog video/audio signal into an analog video signal and an analog audio signal and outputs them. The video A/D converter **126** converts the analog video signal into a digital video signal, while the audio A/D converter **128** converts the analog audio signal into a digital audio signal. The configurations and operations of the analog signal processing section **120,** video A/D converter **126** and audio A/D converter **128** may be well-known ones and the description thereof will be omitted herein.

[0067] The digital video signal representing SD video is output from the video A/D converter **126** to the encoder **138** by way of the switch **134**. On the other hand, the digital audio signal is output from the audio A/D converter **128** to the encoder **138** by way of the switch **136**. The switches **134** and **136** switch the signal paths such that the SD video digital video signal supplied from the video A/D converter **126** and the digital audio signal supplied from the audio A/D converter **128** are both transmitted to the encoder **138**. In response, the encoder **138** generates a data stream representing SD video from the digital video signal received. Also, the encoder **138** generates a PS when the recorder is loaded with the DVD **102** and generates a TS when the recorder is loaded with the BD **104**. In this case, the same processing is carried out as when the digital video signal and digital audio signal are received from the resolution converting section **130** and the digital signal processing section **110**, respectively, and the description thereof will be omitted herein.

[0068] Hereinafter, it will be described with reference to

FIG. **9** how the recorder **100** operates. FIG. **9** shows the procedure of the processing to be done by the recorder **100** that has received a digital signal. First, in Step **S91**, the drive control section **144** recognizes the type of the loaded disk as a BD or a DVD and transmits disk type information to the system control section **140**. Next, in Step **S92**, the stream extracting section **112** of the digital signal processing section **110** receives a TS and selects a channel requested.

[0069] Subsequently, in Step **S93**, the switch **114** receives the disk type information from the system control section **140** and determines whether the given disk is a DVD or not. If the answer is NO (i.e., if a BD has been inserted), then the process advances to Step **S94**. On the other hand, if the answer is YES (i.e., if a DVD has been inserted), then the process advances to Step **S95**. In Step **S94**, the TS on the selected channel is transmitted from the digital signal processing section **110** to the drive control section **144** by way of the switch **132** and is recorded on the BD **104** while maintaining the data structure of the TS. And when the recording operation is finished, the processing of the

recorder **100** also ends.

[0070] In Step **S95,** the resolution converting section **130** receives the non-compressed digital video signal that has been decoded by the decoder **116** and determines whether the video represented by that signal is HD video or not. If the signal represents HD video, the process advances to Step **S96.** Otherwise (i.e., if the signal represents SD video), then the process jumps to Step **S97.** In the latter case, the resolution converting section **130** outputs the SD video as it is without processing it. In Step **S96,** the resolution converting section **130** converts the HD video into SD video. Then, the process advances to Step **S97.**

[0071] In Step **S97,** the encoder **138** generates a PS from the SD video digital video signal supplied from the resolution converting section **130** and the digital audio signal supplied from the digital signal processing section **110.** The specific processing to be carried out in Step **S97** will be described more fully later with reference to FIG. **10.** Then, in Step **S98,** the drive control section **144** records the resultant PS on the DVD **102.**

[0072] In the processing step **S94** described above, the TS is recorded on the BD **104** as it is without determining whether the video included in the TS is HD video or SD video. However, if the video is HD video, the HD video may be converted into SD video and then the SD video may be recorded on the BD **104**. In that case, the TS may be decoded once to convert the HD video into the SD video and then a TS may be generated again. If the latter TS is written on the BD **104**, then its data size is much smaller than that of the former TS. As a result, more programs can be stored on the BD **104**.

[0073] The process shown in FIG. **9** is carried out when a digital signal is received but is applicable in substantially the same way to a situation where an analog signal is received. In that case, however, not the TS but an analog video/audio signal is received in Step **S92**. In Step **S94**, a TS generated from the analog video/audio signal is recorded on the BD. And there is no need to carry out the processing steps **S95** and **S96**.

[0074] Hereinafter, a PS generating process will be described in detail with reference to FIG. **10**.

[0075] FIG. **10** shows the procedure of the PS generating process to be done by the recorder **100** of this preferred embodiment. According to this procedure, the PS generating process changes depending on whether the disk inserted is a DVD-R or a DVD-RAM (i.e., according to the type of the given DVD **102**).

[0076] First, in Step **S101**, the encoder **138** determines whether or not the audio signal received includes multiple audio streams. As used herein, the "multiple audio streams" refer to respective audio streams representing original audio and dubbed audio for a bilingual telecast, for example. If the answer is YES, then the process advances to Step **S102**. Otherwise, the process advances to Step **S103**. It is necessary to determine whether or not there are multiple audio streams because the method of processing multiple audio streams changes depending on whether the given disk is a DVD-R or a DVD-RAM.

[0077] Next, in Step **S102**, the encoder **138** determines whether the DVD **102** on which the PS is going to be written is a DVD-R or a DVD-RAM. If it is a DVD-R, the process advances

to Step **S104**. On the other hand, if it is a DVD-RAM, then the process advances to Step **S105**. This decision may be made on the basis of the disk type information, for example.

[0078] In Step **S103**, a part of the encoder **138**, including the audio encoder **70b** through the audio pack generating section **74b** shown in FIG. **7**, processes the digital audio signal of the audio stream, thereby generating audio packs. After that, the process advances to Step **S106**.

[0079] Meanwhile, in Step **S104**, the audio encoder **70b** generates audio packs based on the digital audio signal of a single pre-selected audio stream. It is impossible to record a plurality of audio streams in parallel on a DVD-R. Besides, a number of independent audio streams cannot be multiplexed on a DVD-R within a single audio stream, either. For that reason, if the program to be recorded includes a plurality of audio options and if the disk inserted is a DVD-R, then an alert is supposed to pop up on the screen to prompt the user to select his or her desired audio option and the user is supposed to have already made his or her selection in response to that alert. In Step **S104**, only the audio stream selected

in this manner is compressed and encoded and stored as PS audio data. After that, the process advances to Step **S106**.

[0080] On the other hand, in Step **S105**, the audio encoder **70b** generates audio packs for a single audio stream based on the digital audio signals of a plurality of audio streams. As in a DVD-R, it is impossible to record a plurality of audio streams in parallel on a DVD-RAM, either. However, unlike a DVD-R, data representing a number of independent audio streams can be multiplexed on a DVD-RAM within a single audio stream. For example, the original audio may be recorded on channel L1 and the dubbed audio may be recorded on channel R1. Thus, the audio encoder **70b** compresses and encodes the multiple incoming audio signals, thereby generating a single audio stream. After that, the process advances to Step **S106**.

[0081] In Step **S106**, the digital video signal representing the SD video is processed by the components, including the video encoder **70a** through the video pack generating section **74a** shown in FIG. **7**, thereby generating video packs. And then the process advances to Step **S107**.

[0082] Finally, in Step **S107**, the multiplexing section **75**

multiplexes the audio and video packs together and outputs them as a PS. By performing these processing steps, a PS can be generated in a format associated with the type of the DVD **102** for use as a storage medium.

[0083] Hereinafter, it will be described with reference to FIG. **11** how the recorder **100** performs a video recording operation on the HDD **106**. FIG. **11** shows the procedure of the video recording operation to be done by the recorder **100** of this preferred embodiment. This video recording operation is characterized by not just merely recording a program on the HDD **106** but also making the recorded program ready to be dubbed onto the DVD **102** in the future.

[0084] In the following description, the disk as the target of the dubbing operation is supposed to be either a DVD-R or a DVD-RAM, not the BD **104**. This is because when dubbing needs to be done from the HDD **106** onto the BD **104**, no stream converting process needs to be carried out but the data may be transferred as it is. The process of recording video on the BD **104** and the process of recording video on the HDD **106** are essentially identical with each other. In either case, a TS

is written while maintaining its data structure. That is why to make dubbing onto the BD **104**, it should be enough to perform the processing steps **S112** and **S113** to be described later.

[0085] First, in Step **S110**, the system control section **140** receives an instruction on whether or not video should be recorded in a direct recording mode. This selection may be made by the user in response to an alert that has been popped up on a TV screen (not shown) by the system control section **140** during a recording mode setting, for example. If the user does not want to record the video in the direct recording mode, the process advances to Step **S111**. On the other hand, if the user does want to record it in the direct recording mode, then the process advances to Step **S112**.

[0086] In Step **S111**, the system control section **140** receives information specifying the type of the disk as the target of the dubbing operation. For example, if the user is going to use a DVD-R, then the user enters information designating a DVD-R. Then, in accordance with that information, the system control section **140** can know the type

of the disk as the target of the dubbing operation. Alternatively, if an optical disk has already been inserted, then the system control section **140** may receive the disk type information from the drive control section **144** and recognize the type of disk inserted by that information.

[0087] Meanwhile, in Step **S112**, the digital signal receiving section **108a** receives a TS **10** and the digital signal processing section **110** selects a channel requested. Next, in Step **S113**, the drive control section **144** records the TS **10** on the selected channel on the HDD **106** to end the process.

[0088] On the other hand, in Step **S114**, the digital signal receiving section **108a** also receives the TS **10** and the digital signal processing section **110** also selects a channel requested. Then, in Step **S115**, the stream extracting section **112** determines whether the video extracted from the TS **10** is HD video or not. As described above, this decision can be made by the descriptor in the header of the stream. If the answer is YES, the process advances to Step **S116**. Otherwise, the process jumps to Step **S117**.

[0089] In Step **S116**, when the video stream of the TS **10** is

decoded by the decoder **116**, the resolution converting section **130** converts that HD video into SD video. Then the process advances to Step **S117**.

[0090] In Step **S117**, the system control section **140** determines whether the type of the target disk of the dubbing operation is a DVD-R or not. If the type of the target disk is a DVD-R, the process advances to Step **S118**. If it is a DVD-RAM, the process advances to Step **S119**.

[0091] In Step **S118**, the encoder **138** generates a PS for a DVD-R. As used herein, the "PS for a DVD-R" refers to a PS generated as a result of the processing steps **S104**, **S106** and **S107** shown in FIG. **10** if multiple audio streams are included in the TS.

[0092] Meanwhile, in Step **S119**, the encoder **138** generates a PS for a DVD-RAM. As used herein, the "PS for a DVD-RAM" refers to a PS generated as a result of the processing steps **S105**, **S106** and **S107** shown in FIG. **10** if multiple audio streams are included in the TS.

[0093] Finally, in Step **S120**, the drive control section **144** records the resultant PS on the HDD **106** to end the process.

[0094] According to this process, a PS that is ready to be written as it is on a DVD-R or a DVD-RAM is stored on the HDD **106**. Thus, when the dubbing operation is carried out, there will be no need to perform a process that it takes a relatively long time to finish (e.g., a stream analysis) but the data of the PS will have only to be copied. As a result, high-speed dubbing is realized. In making a dubbing operation onto the BD **104**, the data of the TS **10** stored on the HDD **106** just needs to be copied onto the BD **104** as it is (i.e., without changing its data structure at all) as described above.

[0095] Hereinafter, a dubbing operation, including these processing steps, will be described with reference to FIG. **12**, which shows the procedure of the dubbing process to be done by the recorder **100** of this preferred embodiment.

[0096] First, in Step **S121**, the system control section **140** recognizes the type of the loaded disk by the disk type information provided by the drive control section **144**. In this case, the disk type is BD, DVD-R or DVD-RAM.

[0097] Next, in Step **S122**, the system control section **140**

determines whether the target disk is the DVD **102** or not. If the answer is NO (i.e., if it is the BD **104**), the process advances to Step **S123**. If the answer is YES (i.e., if it is the DVD **102**), the process advances to Step **S124**.

[0098] In Step **S123**, the drive control section **144** reads the TS **10** from the HDD **106** and records it on the BD **104**.

[0099] Meanwhile, in Step **S124**, the system control section **140** further recognizes the type of the DVD **102** as either a DVD-R or a DVD-RAM and determines whether or not a PS associated with that type is present on the HDD **106**. As used herein, the "PS associated with the type" means a PS for a DVD-R if the target disk is a DVD-R or a PS for a DVD-RAM if the target disk is a DVD-RAM. Each of these terms is just as defined for the processing steps **S118** and **S119** shown in FIG. **11**. If there is a PS associated with the type of the DVD **102**, the process advances to Step **S125**. Otherwise, the process advances to Step **S126**.

[0100] In Step **S125**, the drive control section **144** reads the associated PS from the HDD **106**. Next, in Step **S127**, the drive control section **144** records that PS on the target disk

(which may be a DVD-R or a DVD-RAM).

[0101] Meanwhile, in Step **S126**, the TS is read out from the HDD **106** and a PS is generated according to the type of the DVD. This processing step will be described in more detail. First, the drive control section **144** reads the TS from the HDD **106** and then sends the TS to the decoder **116** in the digital signal processing section **110**. In response, the decoder **116** splits the TS into a video stream and an audio stream and then decodes these streams, thereby outputting a video signal and an audio signal. If the output video signal represents HD video, the resolution converting section **130** converts the HD video into SD video. On the other hand, if the output video signal represents SD video, then the resolution converting section **130** outputs the video signal representing the SD video as it is. Optionally, the resolution of the SD video may be converted into a different resolution if necessary within the resolution range defined for the SD video. Thereafter, the video signal representing the SD video and the audio signal are sent to the encoder **138**. Then, the encoder **138** carries out the process shown in FIG. **10**, thereby generating a PS

associated with the type of the DVD. Finally, in Step **S127**, the drive control section **144** records that PS on the target disk (which is a DVD-R or a DVD-RAM). The dubbing process is completed by performing these processing steps.

[0102] The processing step **S126** is similar to the conventional dubbing process. However, the recorder **100** of this preferred embodiment combines this processing step **S126** with other unique processing steps (such as Steps **S124**, **S125** and **S127**), thereby complementing the conventional dubbing process.

[0103] As described above, in the dubbing process carried out either in Step **S123** or through Steps **S124**, **S125** and **S127**, there is no need to perform the process of analyzing the data of the PS or TS, the process of converting the video quality and so on. Thus, compared to the situation where those processes need to be done, the dubbing process can be finished in a much shorter time.

[0104] A known device that can perform digital recording on a DVD usually includes not only a signal processor, which carries out substantially the same processing as the analog

signal processing section **120** described above, but also an encoder that receives a digital signal from that circuit and converts it into a PS. For that reason, the increase in cost caused by providing the analog signal processing section **120** and encoder **138** usually does not pose a big problem. In this preferred embodiment, the encoder **138** provided for that purpose is used to generate a PS to be recorded on a DVD when a TS is received. Even when the TS needs to be converted into a PS, the encoder **138** performs the same processing because the output of the digital signal processing section **110** has already been decompressed. That is why just the resolution converting section **130** and switches **134** and **136** need to be added. According to this preferred embodiment, when a TS is received, the video may have its resolution converted if necessary and then may be recorded directly on a DVD. Thus, the conventional encoder **138** can be used effectively and the handiness can be increased for the users.

[0105] It should be noted that the video stored on the DVD **102** is always SD grade. Thus, the recorder **100** may store resolution information, indicating whether the broadcast video

is SD video or HD video, in a PS and then record the PS on the DVD **102**. For example, if the HD video has been converted into the SD video, then a value showing that the video used to be HD video before the conversion may be described. On the other hand, if the SD video remains the same, then a value showing that the video has always been SD video may be described. And when that program is played back, the user is informed of the grade of the broadcast video by means of its resolution information. As a result, the user can know whether the program was broadcast as SD video or HD video. If it was broadcast as HD video, then the user can recognize the source of the HD video and can know that the video may be separately available as HD video. This method is particularly effectively applicable to a preset recorded program. In recording a PS compliant with the DVD Video Recording standard, for example, the information showing whether the broadcast video was SD video or HD video may be described in the manufacturer's information field of an RDI pack compliant with that standard. The "manufacturer's information field" is a data field in which arbitrary information defined in advance by the

manufacturer of the recorder **100** can be described as attribute information and is known to those skilled in the art.

[0106] The processing involving format conversion has been described by way of various examples. The format conversion is also called "transcoding" and may be carried out in various modes, which may be roughly classifiable into the categories of:

(1) Stream format conversion;

(2) Coding format conversion;

(3) Resolution/frame rate conversion; and

(4) Bit rate conversion.

Hereinafter, it will be described which of these four categories the conversion process of this preferred embodiment belongs to, along with other examples belonging to the other categories.

[0107] The stream format conversion (Category (1)) is carried out mainly by the encoder **138**. The conversion in this category includes not only a conversion of a TS into a PS as described for the preferred embodiment of the present invention but also a conversion of a PS compliant with the DVD

Video standard into a PS compliant with the DVD Video Recording standard. Each of these conversions is realized by adapting the encoder **138** to that specific conversion. For example, the encoder **138** may be implemented either as a dedicated chip circuit or by making a general-purpose microcomputer execute a dedicated processing program.

[0108] The coding format conversion (Category (2)) is also carried out mainly by the encoder **138**. Examples of conversions belonging to this category include a stream conversion between the MPEG-2 standard and the MPEG-4 standard, a stream conversion between the Windows® Media Video 9 standard and the MPEG-4 standard, and a stream conversion from the MPEG-2 standard into the MPEG-4 AVC standard. Each of these conversions may be carried out bidirectionally.

[0109] The resolution/frame rate conversion (Category (3)) is carried out mainly by the resolution converting section **130**. Examples of resolution conversions belonging to this category include a conversion of HD video into SD video as described for the preferred embodiment of the present invention, a resolution conversion between the D1 standard and

the QCIF standard, and a resolution conversion between the VGA standard and the QVGA standard. The frame rate conversion may be a conversion of 30 frames per second into 15 frames per second, for example.

[0110] The bit rate conversion (Category (4)) is carried out mainly by the encoder **138**. The conversion belonging to this category may be a conversion of 8 megabits per second into 2 megabits per second, for example.

[0111] The various standards mentioned in these categories (1) through (4) are well known in the art and their data structures are known to those skilled in the art. Thus, detailed description thereof will be omitted herein. Also, a conversion process between two standards may be realized by decoding a given stream and converting it into a digital baseband signal once and then encoding the signal in a format compliant with the standard in question. It should be noted that if the coding methods are the same, for example, the data stream sometimes does not have to be decoded into a digital baseband signal. For example, in converting a PS compliant with the DVD Video standard into a PS compliant with the DVD

Video Recording standard, the data in the video and audio elementary streams are the same between the two PS and can be used as it is without decoding that data. Thus, just by describing a pack header or converting a control pack (e.g., from a navi pack into an RDI pack), the stream conversion can be done without debasing the video/audio quality.

[0112] The format conversions in these categories (1) through (4) may be carried out either by themselves or in combination. Thus, an exemplary combination has been mentioned in the preferred embodiment of the present invention described above. Another combination may be the process of converting an MPEG2-TS (HD video) stored on the HDD **106** to watch it on a TV set into an MPEG-4 compliant stream (SD video) to watch on a cell phone. In this example, the conversion of the MPEG2-TS into the MPEG-4 compliant stream belongs to Category (2) and the resolution conversion of HD video into SD video belongs to Category (3). The MPEG-4 compliant stream generated as a result of the conversion process may be transmitted to the memory card control section **146** of the recorder **100** and is written by the memory card

control section **146** on the SD memory card **148** that has been inserted into the recorder **100**. Then, the SD memory card **148** is removed from the recorder **100** and is inserted into the cell phone. When the MPEG-4 compliant stream is decoded by the cell phone, video and audio can be watched and listened to. In generating an MPEG-4 compliant stream, processes belonging to Categories (3) and (4) may be further performed from the standpoint of data size available. For example, it is practical to convert the frame rate from 30 frames per second into 15 frames per second. In addition, since the display of a cell phone is smaller than that of a TV set, it is also practical to convert the bit rate from 8 megabits per second into 768 kilobits per second.

[0113] In the preferred embodiment described above, the video and audio switches **134** and **136** are supposed to receive a digital video signal from the digital signal processing section **110** and a digital audio signal from the analog signal processing section **120**, respectively. However, the video and audio switches **134** and **136** may receive those signals from other processing sections and output them to the encoder **138**.

For example, the recorder **100** may be further provided with another interface compliant with the DV standard and a processing section (DV codec) that can process a DV compliant stream and may be designed such that the video and audio switches **134** and **136** receive a digital video signal and a digital audio signal obtained by converting the DV compliant stream.

INDUSTRIAL APPLICABILITY

[0114] The present invention provides a data processor that can record a received data stream directly on an inserted (i.e., removable) storage medium without temporarily storing it elsewhere. No matter whether the received data stream represents high resolution video or standard resolution video, this data processor can record the data stream directly on a storage medium. Thus, compared to the situation where data is temporarily stored somewhere, subjected to a predetermined conversion and then dubbed elsewhere, the device can save the temporary data storage space and the user can save the time and trouble for re-conversion and re-recording.

[0115] Optionally, to make the data processor carry out every preset recording operation just as the user wishes even if he or she has preset the video recording operation but failed to insert a required storage medium, data may be temporarily stored and then subjected to the additional re-conversion and re-recording processes. Then, the handiness of this data processor can be further increased.